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Study on the Effect of Varying Temperature of Viscosity Modifying Admixture (V.M.A) on Properties of Fresh Self-Compacting Concrete

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***Abstract*:- Concrete is one of the most widely manufactured materials in the world. Today's concrete has to fulfill a wide range of requirements in both the fresh and hardened state. In most cases the properties of fresh concrete also affect the quality of the hardened concrete and ultimately its durability. This means fresh concrete has to be correctly proportioned and must remain homogeneous during placing and after compaction in order to avoid effects such as bleeding and segregation. Self-compacting concrete is a concrete that is able to flow and consolidate under its own weight, completely fill the formwork even in the presence of dense reinforcement, whilst maintaining homogeneity and without the need for any additional compaction.Self-Compacting Concrete (SCC) differs from the normal concrete as it has the basic capacity to consolidate under its own weight. But the performances of self- compacting concrete at varying temperature often encountered on sites were ignored, to minimise the effect of the temperature no adjustments to the concrete mixes due to temperature effects were made on the workability, hence ensuring the constant temperature has became a problem at the construction site. This study investigates the effect of varying temperature of viscosity modifying admixture on the properties of fresh self-compacting concrete. It establishes the effect of okra mucilage on the properties of fresh self-compacting concrete. It also establishes the optimum for okra mucilage extract uses as admixture. The mixes of concrete are rich mixes (1:2:3 mix ratio of grade 20 concrete respectively) The dosages of the admixtures were 0.0%, 0.3%, 0.5% 0.7% and 1.0% weight of mixing water in the corresponding mix and the varying temperature of V.M.A used were 27ºc,200 ºc,250ºc, 300ºc and 350ºc. In order to assess the performance of okra mucilage in this research work, the laboratory test were conducted for up to 28 days. The result shown were for fresh self-compacting concrete at varying temperature as stated above while for hardened self- compacting concrete were for 3 day,7days, 14 day, and 28days to determined the low strength, medium strength and high strength of self -compacting concrete. The key function of a VMA is to modify the rheological properties of the cement paste. The objective of this study is to focus on the effect of varying temperature of viscosity modifying admixtures on the properties of fresh self-compacting concrete. For this purpose, okra mucilage was used as VMA. The experimental results have shown that Okra mucilage is a kind of natural water soluble polysaccharide, very effective in stabilizing the rheological properties of self-consolidating concrete.**

Keywords: Self-Compacting concrete, viscosity modifying admixtures, Workability and Mechanical Resistance

1. INTRODUCTION

Self-compacting concrete was developed in Japan 1980s in order to achieve high performance durable concrete structures and with the advancements in concrete technology its use has become widespread all over the world (Okamura & Ouchi, 2003). Self compacting concrete (SCC) is defined as concrete that has an ability to flow under its own weight, to fill the required space or formwork completely and to produce dense and adequately homogeneous material without the need for vibrating compaction (Martin, 2010) The advantage of SCC in its fresh and harden states include economic efficiency (i.e. it may consume high amount of industrial by-product, its reduces construction noise and health hazards (Bartos & Cechura,2001).Compare with ordinary concrete, SCC includes large amount of binder, superplastisizer, viscosity modifying admixture (VMA) (Nehdi & Ozawa,2004)

One of the latest innovations in concrete is the development of improved Viscosity Modifying Admixtures (VMA) also referred to as Stabilisers, Viscosity Enhancing Admixtures (VEA) and Water Retaining Admixtures. Water retaining admixtures are type of VMA already defined in EN 934-2. The key function of a VMA is to modify the rheological properties of the cement paste. The use of viscosity modifying admixtures (VMA) has proved to be very effective in stabilizing the rheological properties and consistency of self-compacting concrete. Viscosity modifying admixtures (VMA) are water-soluble polymers that increase the viscosity of mixing water and enhance the ability of cement paste to retain its constituents in suspension (Schmidt, 2014). Okra Mucilage was limited in use. Therefore, there is need to investigate Okra Mucilage not only at room temperature but also at varying temperature. Furthermore, most previous studies only focused on compressive strength. However, in this research temperature of Okra mucilage also been studied. Self-compacted concrete (SCC) is one of the famous types of concrete but addition of industrial waste additives to partially replace the mixing water and treating concrete at varying temperature in SCC has been proposed for the first time in this study. Performance of concrete in normal environment and elevated temperature gives a comparative analysis (Yoshioka et al.2014,) .The property of concrete to sustain in varying temperature in an environments provides an opportunity to test its behavior during fire outbreak in structures.

Employment of such wastes and their beneficial effects for structures are observed in this study. Although Artificial Neural Network (ANN) is famous in predicting Compressive strength of self-compacting concrete (SCC) (Plank & Hirsch 2014) in this study, new variables have been tested, which are basically related to change of additives, curing conditions, change of type of additive and percentage of additives. The share of self-compacting concrete in the overall concrete production is not large. One of the reasons is a significant impact the temperature has on self-compacting concrete workability. Temperature is a factor in extricable linked to the processes of mixing and casting of concrete. The final temperature of the fresh concrete is influenced by a temperature of the components, ambient temperature, and the heat generated by the mixing. Ensuring the constant temperature is very problematic at the construction site. It is possible only during production of precast concrete. Influence of temperature on the workability of ordinary concrete is well recognized (Yoshioka, 2002) Increasing temperature leads to stiffening of the concrete mixtures. The loss of workability due to the increasing temperature does not disqualify concrete mix yet and correct casting is still possible. Workability loss can be compensated by the higher or longer mechanical vibration. In the case of self-compacting concrete, compaction process is due to the concrete's own weight. Load is caused by mixture's own weight, defeating the yield value, causing the flow of the mixture. The flow rate depends on the plastic viscosity. Increasing the plastic viscosity decreases the flow rate of the mixture. (Gołaszewski & Cygan2016), showed that in some cases a significant loss of SCC workability may occur. In this case, the SCC mixture should be mechanically vibrated till it reaches adequate compaction (fig1). (Ghafoori & Diawara 2016), reached similar conclusions. According to them, above a temperature of 20°C,slump flow is declining with increasing temperature; this trend accelerates with rising temperature. According to Schmidt (,2014) it is possible to reduce undesirable temperature influence on SCC workability. It can be done by using suitably selected super plasticizers and other chemical admixtures. By its nature concrete is placed under different environmental conditions. Considering the volume of research done on self compacting concrete, temperature is a factor that is linked to the processes of mixing and casting of concrete. But the performances of self- compacting concrete at varying temperature often encountered on sites were ignored. To minimise the effect of the temperature no adjustments to the concrete mixes due to temperature effects were made on the workability, hence ensuring the constant temperature has became a problem at the construction site. Influence of temperature on the workability of ordinary concrete is well recognized. The mechanism of the effect of temperature on rheological properties of self-compacting concrete mixtures is more complex than in the case of ordinary concrete (Khayat,2003). It is associated with dose and kind of superplasticizer and its temperature resistance in terms of workability. It is also associated with cement type and kind of superplasticizer. In this case, the effect of varying temperature of V.M.A on the properties of fresh self-compacting concrete need to be investigated.

2.0 LITERATURE REVIEW

The literature behind reactant that might take place and their products when cement, aggregate and water react together with viscosity modifying admixture were explained by some researchers like (Khayat & Mitchell,2008)" When a fluid starts to flow under the action of a force, a shearing stress arises everywhere in that fluid that tends to oppose this motion. As one layer of the fluid moves past an adjacent layer, the fluids molecules interact so as to transmit momentum from the faster layer to the slower layer tending to resist the relative motion (Ink, 1995).The yield stress can be considered as the relevant parameter that determines the flow, while viscosity is the relevant parameter that determines the flow velocity. For the stability of a concrete mixture both parameters play an important role. While a high yield stress is required to avoid segregation at rest, a high plastic viscosity is required to avoid segregation at flow. Aside from measuring the flow of concrete, rheology is concerned with the prediction of the flow from the properties of the components (i.e. cement paste, mortar) or from the mix design (i.e. w/c ratio, aggregate content, type of cement and admixture dosage) (Ferraris, 1999). As opposed to a solid, for a fluid, the distinguishing feature is the ease with which the fluid may be deformed. When a shearing force is applied to a fluid, irrespective of how small it might be, the fluid starts to move and continues to move as long as this force is acting on it (Ink, 1995).Viscosity, which is defined as a measure of fluids resistance to flow; creates a resistance to this flowing fluid under the applied force. The decrease in slump flow and increase in segregation resistance due to environmental temperature has also been observed by Aarre and Domone, (2004).There are two categories of fluids namely, Newtonian and non-Newtonian. Newtonian fluids are characterized by a single coefficient of viscosity for a specific temperature. The viscosity changes with changing temperature but remains constant with changing strain rate.

3.0 MATERIAL, METHOD AND PROCEDURE

Many different methods have been developed to characterize the properties of SCC. As no single method has been found till date, that characterizes all the relevant workability aspects, the mix was tested by more than one test method for the different workability parameters. The following test methods were used to characterize the workability properties of SCC for the final acceptance of the SCC mix proportion; Slump flow test and diameter, L-Box ratio test, J-ring passing ability test and V-funnel flow time test

3.1 Materials used

A. Cement

Ordinary Portland cement of available in local market was used in the investigation. The cement used was tested for various proportions as per IS 4031 – 1988 and found to be confirming to various specifications of IS 12269-1987.

B. Coarse Aggregate

Aggregate is a granular material such as sand, gravel, crushed stone, iron blast finance slag etc used in production of concrete. Therefore for the purpose of this study gravel was used for the production of self- compacting concrete.

C. Quartz Sand

Quartz has a hardness of 7 on Mohs scale and a density of 2.65 g/cm³. Quartz is a common constituent of granite, sandstone, limestone, and many other igneous, sedimentary, and metamorphic rocks. It has a hexagonal crystal structure and is made of trigonal crystallized silica. Present investigations of the sand properties were made.

D. Viscosity Modifying Agent (okra mucilage)

A Viscosity modified admixture Okra mucilage admixture was used to develop concrete with enhanced viscosity and controlled Rheological properties.

3.2 Experimental Method

A cement content of 356 kg/m3 was used for the self compacting concrete. Water was adjusted to yield a slump of approximately 75 mm at 27°C. This resulted in a water-to-cement ratio of 0.45. These mix designs were held constant throughout the program. No adjustment was made for mixes cast at either higher or lower temperatures; thus, workability changed for mixes cast at either high or low temperature. As previously pointed out, this approach was taken to isolate the effects of temperature of Viscosity modifying admixture. As there is no standard procedure available for designing the mix proportions for Self Compacting Concrete (Aarre and Domone, 2004). Proportion based on the Experimental trail was adopted.

3.3 Development of Self- Compacting Concrete

Self-Compacting concrete was prepared using 1:2:3 mix ratios, 0.0%, 04%, 0.8%,1.2% and 1.6% of Okra mucilage (VMA) of w/ratio at varying temperature of 27^{o}c, 200^{o}c, 250^{o}c, 300^{o}c. was added to homogenous mixture of ordinary concrete. SCC was developed.

The J ring, L-Box/glson static segregation column, V funnel, and Slump flow tests were performed. Cubes of dimensions 150 mm by 150 mm by150 mm were cast. All samples were allowed to cure in curing tanks filled with fresh water.The curing process was done for 7, 14 and 28 days. After curing, cube samples were tested in a Compressive Test Machine. The strength tests were carried out carefully on best-attained samples from the stock of casted samples for different percentage replacements.

3.4Test Procedure

The cleaned base plate was placed in a stable and level position. The bucket was filled with 6 litres of representative fresh SCC and the sample was allowing stand still for about 1 minute (± 10 seconds).During the 1-minutewaiting period the inner surface of the cone and the test surface of the base plate was pre-wet using the moist sponge, and the cone was placed in the centre on the 200 mm circle of the base plate and the weight ring was put on the top of the cone to keep it in place. (If a heavy cone is used, or the cone is kept in position by hand no weight ring is needed).Guidelines TESTING-SCC September 2005.The cone was filled with the sample from the bucket without any external compacting action such as Roding or vibrating. The surplus concrete above the top of the cone was struck off, and any concrete remaining on the base plate was removed. It was checked and make sure that the test surface is neither too wet nor too dry. No dry area on the base plate was allowed and any surplus of the water was removed – the moisture state of the plate has to be ‘just wet’. After a short rest (no more than 30 seconds for cleaning and checking the moist state of the test surface), The cone was lift perpendicular to the base plate in a single movement, in such manner that the concrete is allowed to flow out freely without obstruction from the cone, and the stopwatch started, the moment the cone loses contact with the base plate. The stopwatch was stop when the front of the concrete first touches the circle of diameter 500 mm. The stopwatch reading was recorded as the T50 value. The test was completed after the concrete flow has ceased. NOTE Dot not touches the base plate or otherwise disturb the concrete until the measurement Described below was completed. The largest diameter of the flow spread, *d*max, and the one perpendicular to it, *D*perp was measured, using the ruler.

3.5 Column Segregation Test:

A sample of freshly mixed concrete is placed in a cylindrical mold (column) without tamping or vibration and allowed to stand undisturbed for a specified duration. The mold has three sections representing different levels of the mold. Concrete samples from the top and bottom section and washed on a No. 4 (4.75 mm) sieve . The masses of saturated surface dry (SSD) coarse aggregate in the top and the bottom sections were determined.

4.0 RESULT AND DISCUSSION

RESULTS for flowing ability, passing ability and static segregation

VARYING TEMPERATURE OF **OKRA MUCILAGE** AT DIFFERENT PERCENTAGE OF REPLACEMENT

Table (1): Results of Fresh Properties of SCC (VMA at Room Temp.of 27 oC)

Okra mucilage %	**Test age (min)**	**Slump flow Dmm**	**J-Ring DJ (mm)**	**(D-DJ) mm**	**Static Segregation %**
0.0	0.0	250	248	2	14
0.4	5.0	300	295	5	12
0.8	10	550	542	8	8
1.2	15	615	605	10	6
1.6	20	670	658	12	4

Table (2): Results of Fresh Properties of SCC (VMA. Temperature at 200 oC)

Okra mucilage %	**Test age (min)**	**Slump flow Dmm**	**J-Ring DJ (mm)**	**(D-DJ) mm**	**Static Segregation %**
0.0	0.0	250	248	2	14
0.4	5.0	280	270	8	11
0.8	10	500	485	15	7
1.2	15	605	590	15	6
1.6	20	610	593	16	3

Table (3): Results of Fresh Properties of SCC (VMATemperature at 250 oC)

Okra mucilage %	**Test age (min)**	**Slump flow Dmm**	**J-Ring DJ (mm)**	**(D-DJ) mm**	**Static Segregation %**
0.0	0.0	250	248	2	14
0.4	5.0	270	264	6	10
0.8	10	490	475	15	7
1.2	15	600	584	16	4
1.6	20	605	587	18	2

Table (4): Results of Fresh Properties of SCC (VMATemperature at 300 oC)

Okra mucilage %	**Test age (min)**	**Slump flow** Dmm	**J-Ring DJ (mm)**	**(D-DJ) mm**	**Static Segregation %**
0.0	0.0	250	248	2	14
0.4	5.0	268	263	5	9
0.8	10	475	465	10	7
1.2	15	598	587	11	3
1.6	20	600	583	17	2

Table (5): Results of Fresh Properties of SCC (VMA Temperature at 350 oC)

Okra mucilage %	**Test age (min)**	**Slump flow D mm**	**J-Ring DJ (mm) (D-DJ) mm**	**Static Segregation %**	
0.0	0.0	250	248	2	14
0.4	5.0	268	264	4	8
0.8	10	468	460	8	6
1.2	15	595	585	10	3
1.6	20	598	582	16	1

Table (6): Requirements of ACI Committee 237

Property	**Requirements Tests**	**Tests method**
Slump Flow	Less 550 mm, 550 to 650 mm and greater than 650 mm. The required slump flow value will vary depending on the workability needed for a certain application	ASTM C1611
J-Ring	The difference between J-ring flow and the slump flow must not exceed 50mm	ASTM C1621
Column Segregation	Static Segregation must not exceed 15%	ASTM C1610

4.5 RESULTS FOR COMPRESSIVE STRENGTH AT 7,14 AND 28 DAYS OF CURING

Table (7): Results of Compressive Strength Test for SCC made with Okra Mucilage at 7days curing

Varying temp (^{0}c)	**% replacements of mixing water with okra mucilage**				
	0.0	0.4	0.8	1.2	1.6
27	28.3	17.5	17.0	16.9	16.1
200	27.4	16.9	16.6	16.3	16.2
250	26.5	15.9	15.3	15.1	14.8
300	23.3	14.2	13.6	13.2	14.2
350	22.6	13.9	13.2	13.0	12.8

Table (8): Results of Compressive Strength Test for SCC made with Okra Mucilage at 14days curing

Varying temp (^{0}c)	**% replacements of mixing water with okra mucilage**				
	0.0	0.4	0.8	1.2	1.6
27	29.3	18.5	17.5	16.9	16.1
200	27.4	17.9	16.6	16.3	15.9
250	26.5	16.9	16.3	16.1	15.8
300	25.3	16.2	15.6	15.2	15.2
350	23.6	15.9	15.2	15.0	14.8

Table (9): Results of Compressive Strength Test for SCC made with Okra Mucilage at 28days curing

Varying temp (^{0}c)	**% replacements of mixing water with okra mucilage**				
	0.0	0.4	0.8	1.2	1.6
27	31.3	31.5	25.5	20.9	20.1
200	32.4	28.9	24.6	19.3	18.2
250	31.5	28.9	24.3	18.0	17.8
300	30.3	27.9	23.6	17.2	16.2
350	29.6	27.2	22.2	16.3	15.8

4.1 Fresh properties of self compacting concrete

The fresh properties tests of SCC mixes were repeated every 5 minutes after brief re-mixing, from the results shown in Table (5) to (9) and Figs. (1), (2) and (3) it can be seen that, at 1.2 percent of replacement of VMA'S when the test age were 5 and 15 minutes, the slump flow, J-ring and column segregation tests varied from 580 to 610 mm , 10 to 20 mm and 13 to 15 % respectively. These results show that the self compacting concrete used was complied with the requirements of ACI Committee 237 as seen in Table (1-9). at 0.4 percent of replacement of VMA'S the slump flow and passing ability of SCC mixtures were slightly lost. However, the slump flow and passing ability of SCC mixtures lost significantly at 0.0 percent of replacement of VMA'S. Except the segregation resistance of SCC increased as % replacement increased due to increase in temperature. Figs. (3) Show the flowing ability of SCC mixtures after 0 and 30 minutes from the end of mixing respectively. Figs. (1) Also show the passing ability of SCC mixtures through an obstacle after subjecting VMA's to a varying temperature at different % of replacement of mixing water respectively. The decrease in slump flow, due to environmental temperature has also been observed by (Petersson, 1998). (Aarre and Domone ,2004) test results also showed that the environmental temperatures had a notable effect on the fresh properties of SCC. Figs. (1) and (3) show that the slump flow and passing ability at 350 ºC seriously lost more than that of 200 ºC. The results shown in table (5-9) indicated that the addition of VMA'S% by weight of mixing water in concrete after subjecting to a varying temperature show that, from the end of mixing, brought the SCC mix back to its initial fresh properties and maintaining a further workability period of about 15 minutes.

4.2 Properties of hardened self compacting concrete

Compressive Strength: Fig. (16) Shows the compressive strength for SCC at varying temperatures. At the test ages of 0 minute and 15 minutes after the end of mixing with temperature of 200 ºC, slump flow is greater than 550 mm, there was no difference in the compressive strength because SCC was fully consolidate without the need for vibration. Beyond 15 minutes, the compressive strength drops significantly and at 250 oC and 300 oC the reduction in compressive strength were 16 and 34 percent respectively. The drop in the compressive strength of SCC is due to the fact that the mix has lost its ability to self-compact. Furthermore, at 350 oC, slump flow greater than 550 mm, the compressive strength value was about 33.6Mpa.Compressive strength data are presented in tabular format in Tables 5 and 6. The four test conditions included concrete cast and cured at 27°C, concrete cast and cured at 200°C, concrete cast and cured at 250°C, concrete cast and cured at 300°C and concrete cast and cured at 350°C. In general, the effect of low temperature casting and curing was lower at early age strength than concrete cast and cured at high temperature. Concrete cast and cured at 350°C had three-day strengths of 66 to87% of concrete cast and cured at 200°C. After 28 days, concrete cast at low temperature had compressive strength nearly equal to or in excess of concrete cast and cured at 300°C, the effect on compressive strength was relatively small. The effect of elevated temperature was the opposite of that of low temperature. Earlier age strength was higher than that of concrete cast and cured at high temperature, while later age strength was lower.After three days concrete cast and cured at 27°C, had developed 71% of its 28-day Strength of concrete made with Okra mucilage. Three-day relative strength development of concrete cast and cured at high temperature was similar to seven-day relative strength development of concrete cast and cured at low temperature. In all cases, after 28 days the absolute strength of concrete made with Okra mucilage cast and cured at higher temperature is slightly lower than concrete made with Okra mucilage cast and cured at low temperature.

4.3 Effect of Okra Mucilage Temperature on the Flowing Ability Passing Ability and Segregation Resistance of Fresh Self-Compacting Concrete

From the results shown in Tables (5 - 9) and Figs (4, 5,6 and 7) it can be seen that, when the dosage were increases, the flowing ability and passing ability also increases. the tests varied from 250 to 700 mm flowing and 5 to 20 mm passing. These results show that the self compacting concrete used was complied with the requirements of ACI Committee 237 as seen in Table (6) when the temperature increases the slump flow and passing ability of SCC mixtures were slightly decreases**.** However, the passing ability of SCC mixtures increases significantly at 0.8% dosage VMA's. Figs (1 and 2) shows that the slump flow and passing ability of 350 ^{0}C seriously lost more than that of 200 ^{0}C

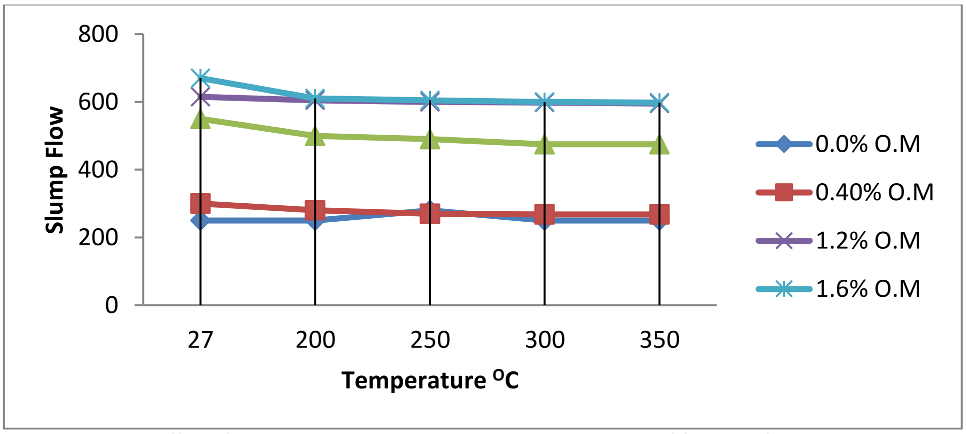

Fig. 1 Effect of Okra Mucilage Temperature on the Flow Ability of fresh self- compacting Concrete at different % of replacement

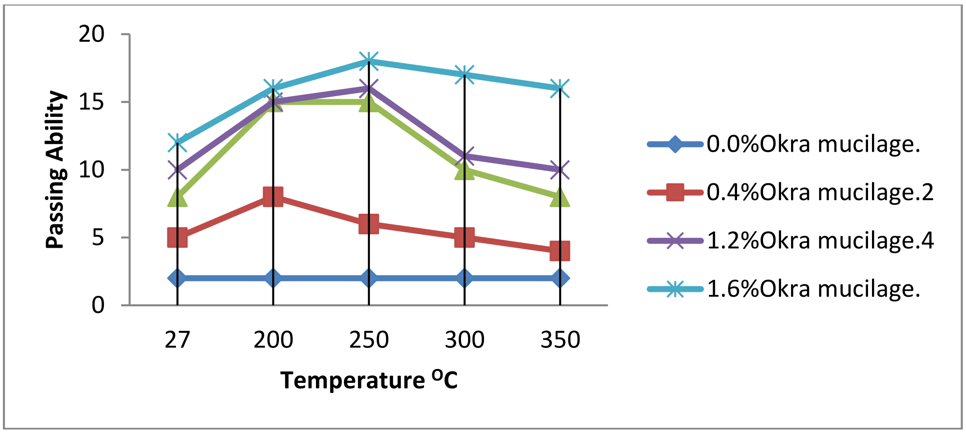

Fig 2. Effect of Okra Mucilage Temperature on the Passing Ability of fresh self- compacting Concrete at different % of replacement

The segregation resistance of SCC decreased as the Temperature of VMA'S increases due to gradual stiffening process. Figs. (3) show the flow ability of SCC mixtures after adding VMA's dosage the result also shows that increase in VMA's dosage increases the segregation resistance of fresh.Test results also showed that the environmental temperatures had a notable effect on the fresh properties of SCC.

The results shown in Fig. (3) indicated that the addition of 0.8% by weight of mixing water in concrete brought the SCCmix back to its initial fresh properties and maintaining a further workability period of about 15 minutes.

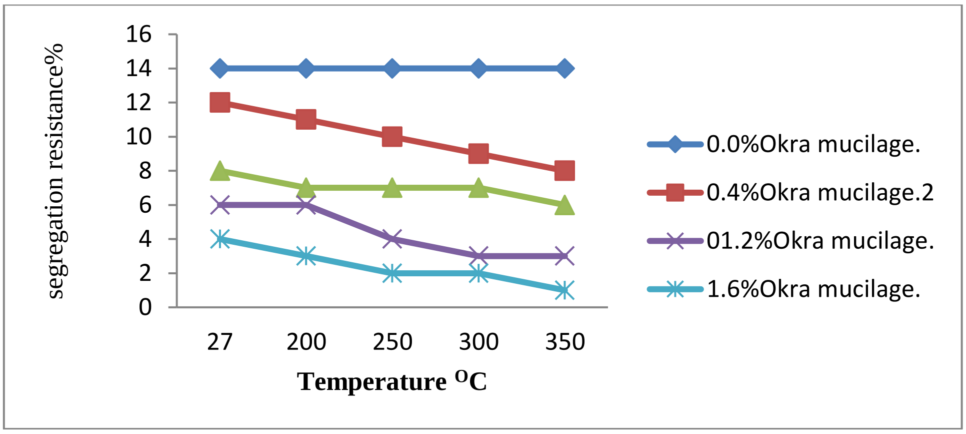

Fig 3 Effect of Okra Mucilage Temperature on the segregation resistance of fresh self- compacting Concrete at different % of replacement

Table 1-5 shows the self-compacting properties of concrete made with Okra Mucilage as VMA. The slump flow test measures the degree of flow ability of the concrete which has a conformity criteria of slump flow class 1 (≥ 520, ≤ 700mm). The L-box tests the passing ability of the concrete through obstacles and also the filling ability of the concrete. It has a conformity value of ≥ 0.75 for a class 1 passing ability The fill-box test measures the filling ability of the concrete through heavily reinforced formwork. The nearer the value of the height measured after the concrete has stopped flowing at the end of the box to the top of the concrete at the tip of the funnel, the greater the ability to compact on its own

4.9 Temperature Effect on the Compressive Strength of Hardened Self-Compacting Concrete

Fig. (16 and 17) shows the compressive strength for SCC as a function of the elapse dosage and Varying temperatures. At the test ages of 28days there was no difference in the compressive strength between SCC and Conventional Concrete, because SCC mix should fully consolidatewithout the need for vibration. the compressive strength drop significantly 1.2 and 1.6% replacement after subjected to high temperature The drop in the compressive strength of SCC is due to the fact that the mix has lost its ability to self-compact. It is obvious from these results shown in Fig.(4) that the compressive strength of SCC decreased when the temperature increases.

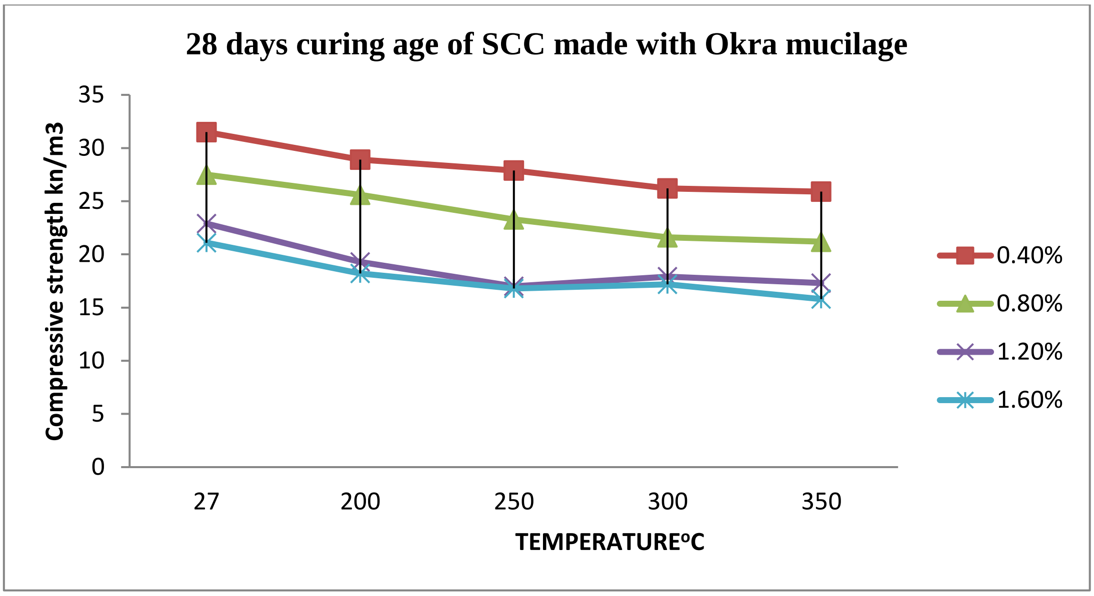

Fig.(4) Relationship between compressive strength of % replacement and temperature of OKRA MUCILAGE In SCC

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In this study Okra mucilage was used as a local additive to investigate the performance of fresh and hardened self-compacting concrete made with Okra mucilage at varying temperature and at different percentage of replacements by establishing the effect of okra mucilage on the properties of fresh and hardened self-compacting concrete, the optimum for okra mucilage that will be use as admixture, also to classify the category of viscosity modifying admixture that Okra mucilage belongs to, through the measure of workability for fresh concrete and compressive strength for hardened concrete in different ages. From the results obtained, the Okra mucilage is environmental friendly because it is Agro-base (vegetable) admixture, unlike mineral admixtures and is a kind of natural water soluble polysaccharide, proven to be very effective in stabilizing the rheological properties of self-consolidating concrete at 1.2% of replacement. As concrete mix with Okra mucilage temperature increased from 200°C- to 250°C, slump decreased approximately 20 mm. Lower temperatures increase set time; higher temperature decrease set time, this shows Increasing temperature leads to stiffening of the concrete mixtures .For self- compacting concretes made with Okra mucilage at 200°C, 7-day compressive strength was approximately 75% of 28-day compressive strength of conventional concrete. At 28-day compressive strength of concrete cast at low temperature (27°C) was nearly equal to that of concrete cast at high temperature (300°C). high temperature of Okra mucilage at early age strength is more effective than that of later age strength.

5.2 Recommendations

This study provides knowledge and records about locally sourced admixture that can be useful in the development and innovation of new technologies in the field of construction. This will provide necessary information for the students in their future research on admixtures. It is an opportunity for the government agencies to utilize a different source of admixtures in their infrastructures, mainly buildings, highways and bridges, which will derived cost savings since it is locally sourced. Also will encourage cultivation of Okra plant not only as food but as Admixtures

REFERENCES

[1] ASTM C1621, "**Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring"** Annual Book of ASTM Standared, 2005, pp. 1-5.
[2] ASTM C1610, "**Standard Test Method for Segregation Resistance of Self-Consolidating Concrete Using Column Technique"** Annual Book of ASTM Standared, 2005, pp. 1-4.
[3] Bartos P.J.M., & Cechura(2001**). Improvement of Working Environmen in Concrete Construction by the use of Self-Compacting Concrete,** *2*(3), 127-135. https://doi.org/10.1680/stco.2001.2.3.127
[4] Ferraris, C. F. (1999). **Measurement of the Rheological Properties of High Performance Concrete** : State of the Art Report, *104*(5).
[5] J.Simmie & martin (2010).**The economicResilence of Regions: Towards an evolutionary Approach,** Cambridge Journal of regions, economy and socieity 3(1),27-43,2010
[6] J. Plank , C. Hirsch, **Impact of zeta potential of early cement hydration phases on superplasticizer adsorption,**Cement and Concrete Research, 37. 537-542,(2007)
[7] Khayat K. H. and Mitchell D.(2008)" **Self-Consolidating Concrete for Precast, Prestressed Concrete Bridge Elements"** Final Report for NCHRP Project 18-12, 170p.
[8] N. Ghafori , H. Diawara, **Influence of temperature on fresh performance of self-consolidating concrete,**Construction and Building Materials,24 (2010) 946-955.

[9] Okamura, H., & Ouchi Masahiro. (2003). **Self-Compacting Concrete**. *Journal of Advanced Concrete Technology*, *1*(1), 5–15. https://doi.org/10.3151/jact.1.5

[10] Ouchi, Nakamura, Osterson, Hallberg, and Lewin. (2003). **Applications of Self-Compacting Concrete in Japan, Europe and the United States.**

[11] .Schmidt, W. (2014). SCC: **A solution to the challenges of concrete construction in Africa.** *CONCRETE TRENDS African Focus* (p. 4).

[12] US INK. (1995). **An Introductory Guide to Rheology**. Retrieved from www.sunchemical.com

[13] Zakka, P.W., Job, O.f, & Anigbogu, N. . (2015). **Ecological Self-compacting Concrete using Gum Arabic as a plasticizer**. In *West Africa Built Environment Research (WABER)* (p. 10).